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Dear Massachusetts Advanced Biofuels Task Force Members,

We are very excited about the Biofuels task force and the Commonwealth's efforts in promoting biofuels technology. The purpose of this letter is to make this task force aware of a lignocellulosic biofuel technology that we are developing, and provide recommendations to the Task Force. Our biofuels team includes: researchers at the University of Massachusetts-Amherst (George W. Huber, Richard Stein, Ted Wysocki, and Robert Essert), Renewable Oil International® LLC (Phillip C. Badger, Claude Breed, and Scott Badger) and the MA Department of Conservation (Gordon Boyce). Renewable Oil International® (ROI) designed and built the Commonwealth's first cellulosic biofuel refinery to produce a liquid biofuel called bio-oil in MA. Researchers at University of Massachusetts-Amherst are developing catalytic routes to convert the bio-oil into home heating oil, gasoline, and diesel fuel supplements or substitutes, as well as high value chemical co-products which can mitigate the cost of biofuels production. Our research team has over 40 years combined experience in working in the area of biofuels and fuels. Over the last 4 years our team has received over \$1.7 million from several federal and state grants to develop new biofuels technology.

Renewable Oil International® has developed a fast pyrolysis technology that can economically produce bio-oils from wood at a cost of \$0.50 per gallon of gasoline equivalent if wood is obtained at zero cost. If wood costs \$40 per dry ton, which is a realistic number for MA, the bio-oils are produced at a cost of \$1.05 per gallon of gasoline equivalent. These costs are based on data obtained in actual pilot plant tests of the fast pyrolysis process. Another advantage of the fast pyrolysis technology is that it is economically viable on the small scale (i.e. 50-100 tons biomass/day). In comparison, other technologies such as cellulosic ethanol and Fischer-Tropsch Synthesis (FTS) require very large scale refineries of 2000-6000 tons of biomass per day to become economically viable. The Commonwealth would only have enough woody biomass feedstock for 1 or 2 of these large cellulosic refineries to be built. In contrast, fast pyrolysis refineries can be built in a distributed fashion where the processing of the biomass is performed close to the location of the biomass. In short, each fast pyrolysis plant becomes a renewable oil well converting inexpensive wood to a bio-oil. In this respect, ROI has designed and built a 15 ton per day biomass pilot demonstration plant in Fitchburg, MA. A schematic of this plant is shown in Figure 1.

Researchers at UMass-Amherst are now developing technology to convert the bio-oils into home heating oil, gasoline, and diesel fuel at a targeted cost of \$1.50 per gallon of gasoline energy equivalent with wood at \$40 per dry ton. We have successfully produced liquid alkanes from the bio-oils, which are the major component of home heating oil, gasoline and diesel fuel. We now are working on optimizing this technology. We are

making good progress and believe that in the future we will be able to economically produce liquid biofuels from MA wood resources.

This project demonstrates the important need for technical development in the area of biofuels, and how Universities and companies can work together to make the technology development happen.

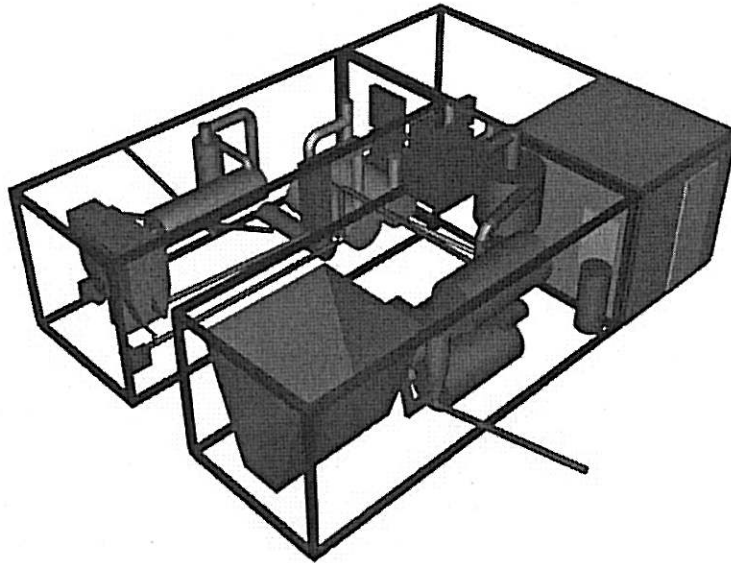


Figure 1: A design of the first cellulosic biofuel refinery built in the Commonwealth by Renewable Oil International® LLC.

Our recommendations to the panel are the following:

1. Any legislation should treat all biofuels the same. In reality, we need all fuel options if we are to meet our future fuel requirements. The commonwealth should not give unfair subsidies to one specific biofuel, and should make sure that any subsidies are given on an energy basis. At this time it is unclear what the least expensive biofuel will be.
2. The state should work with companies in helping to get the proper permits for cellulosic biorefineries. ROI experienced a number of permitting problems as it tried to start up its biorefinery in MA.
3. The state should continue to fund basic research and demonstration projects in biofuel technology. The technology to make lignocellulosic biofuels is not yet commercially available. Encouraging a strong collaboration between the Commonwealth's universities and industry is an important first step in funding basic research.

4. The state should encourage testing of alternative biofuels in state fleet vehicles. A number of new types of biofuels are being developed, and MA should be the first to test and approve these new fuels.

This is clearly an exciting time as we work to end our dependence on imported foreign oil and improve our state's economy by providing another market for MA wood resources.

Sincerely,

Phillip C. Badger, Renewable Oil International® LLC and ROI Massachusetts
Operations LLC

George W. Huber, University of Massachusetts-Amherst, Chemical Engineering
Department

Richard Stein, University of Massachusetts-Amherst, Chemistry Department

Tadeusz S. Wysocki Jr

Robert Essert, Sr.,

Gordon W. Boyce

Biography of authors:

Phillip C. Badger is President & Chief Manager of Renewable Oil International[®] LLC (ROI), located at Florence, Alabama. His qualifications include professional engineering licenses and a MBA. Mr. Badger has designed and constructed fuel ethanol and fast pyrolysis plants and led an ethanol-from-cellulose research team at the Tennessee Valley Authority. He has also managed a regional bioenergy program for the U.S. Department of Energy and more recently, a bioenergy consulting company, in addition to ROI. He has two patents pending and has published over 60 papers on various bioenergy topics.

George Huber is the Armstrong Professional Development Professor of Chemical Engineering at UMass-Amherst. He has over 10 years experience in working in the area of fuels, biofuels, and heterogeneous catalysis. He has worked on catalysis and biofuel projects for Exxon-Mobil, Cargill, Conoco-Phillips, Virent Energy Systems, Khosla Ventures, and Bio-e-Con to develop catalytic processes for the petrochemical and biorefining industry. He currently has 4 patent applications in the area of catalytic processing of biomass-derived components. He has published over 23 papers in the areas of heterogeneous catalysis, biorefining, and biofuels production. His previous biofuels research is being commercialized by two different start-up companies: Virent Energy Systems and Bio-e-Con.

Richard S. Stein is Emeritus Goessmann Professor of Chemistry at UMass, and familiar with rheology. He is a member of the National Academies of Science and Engineering and has been awarded honorary degrees by the Universitat Ulm and the UMass. Stein initiated the polymer program at UMass and started its Polymer Research Institute which evolved into the Polymer Science and Engineering Department. Stein's efforts have been recognized by awards from the American Chemical Society, the American Physical Society, the Society of Rheology, the Society of Plastics Engineers and the Society of Polymer Science, Japan.

Tadeusz (Ted) S. Wysocki Jr. is a self-motivated Material and Process Engineer with over 35 years of "hands on" experience in project development, and management in the Plastics, Composites, Paper and other chemical and manufacturing Industries. Has work with DuPont, W.R.Grace, General Electric, Albany International, Dexter Corp. , among others. Ted was a semi-finalist in the 1992 Advanced Technology Program at the National Institute of Standards and Technology (NIST) . Long time member of the American Chemical Society resulting in him becoming a Grades K-12 Educational Outreach Volunteer. Served on many municipal and professional committees, and continues to be a educational resource to encourage younger students to pursue higher levels of Science, Technology, Engineering and Mathematics (STEM) Education.

Robert Essert, Sr., Retired Mechanical Engineer, Licensed in the State of New York. Recipient of Ray Blain Award for Excellence in Telecommunications Design, 1991. Seven patents in the field of fiber optics hardware. Currently General Manager of Basicar.com, Div. Essert Assoc, Inc., which offers transportation design to Third World entrepreneurs, including **bio-mass** transportation power development.

Gordon W. Boyce is the MA Department of Conservation and Recreation Marketing and Utilization Forester. In that position Gordon relies on his 30 + years of private sector experience in the Forest Products Industries of Massachusetts and

Washington State, as well as his B. S. degree in Forestry from UMASS, to assist and promote the Forest Products Industries of Massachusetts. Gordon served as past president of Mass Natural Resource Center Cooperative, a cooperative formed to assist producers in the marketing of wood chips, roundwood pulp, and other underutilized, low value forest products. He has also been affiliated with the Massachusetts Wood Producers Association, Massachusetts State Forestry Committee, Northeast Lumber Manufacturers Association, and Council on Forest Engineering. Currently he serves as a Steering Committee member to the Northeast Regional Biomass Program of the Coalition of Northeastern Governors. He is also a past and founding Board Member of the Biomass Energy Resource Center.